Experimental constraints on the timing of degassing of nitrogen in the atmosphere.

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Abstract

Nitrogen dominates the Earth's atmosphere and its availability for life molecules is probably an important criteria for habitability. Nitrogen has isotopic and abundances that suggest a chondritic origin implying that it was probably delivered to planet Earth during the accretion stages. It must have been processed through the magma ocean stage and then possibly released via planetary magmatic outgassing. Ancient rocks indicate that 3.5 Gyrs ago, nitrogen was already present in the atmosphere, but no data exists for the earlier times. This study addresses by experiments at pressure and temperature the behavior and equilibrium partitioning of nitrogen between silicate melt of basaltic composition and a fluid phase. The objective is to reconstruct the history of nitrogen magmatic degassing by planet Earth, establishing the conditions where the nitrogen get out from the silicate melt to the fluid phase enabling its degassing. Experimental conditions of this study are, 1200∘C, 800 to 2400 bar pressure and redox conditions covering the present Earth's magmatism to that of the magma ocean (fO2 between IW and NNO). The analyses of the nitrogen concentration in the silicate glasses were carried out with the secondary ionization mass spectrometry (CRPG, Nancy). Other analyses of the composition of the different phases in the glasses are performed using the electronic microprobe, infrared and RAMAN spectroscopy at ISTO. Despite large amopunt of nitrogen being loaded in the experimental system, the obtained basaltic glasses indicate low nitrogen concentrations (1 to 30 ppm N in silicate glasses) ; these nitrogen concentrations appear to increase as the conditions becomes more reducing and as pressure increases. The data obtained in our study could then be compared with data from the literature. A model of nitrogen solubility in silicate liquids relating the nitrogen content of basalts to temperature, oxidation state (fO2) and N2 pressure in fluid is currently under construction. This model will be used to calculate the nitrogen partitioning between silicate melt and gas in a vast range of conditions. This application can help us for constrain the timing of nitrogen release to the atmosphere by thermodynamic calculations.

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